Recent Results in Surface Deformation Measurements: Spaceborne Repeat Pass Interferometry with ERS, JERS and SIR-C

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The synthetic aperture radar instruments aboard the European ERS-1 and Japanese JERS satellites, and the United States SIR-C/XSAR instrument aboard the space shuttle, have acquired great amounts of data suitable for repeat, pass interferometry. The large spatial and temporal Coverage of ERS (C-band; 5.6 cm wavelength) anti JERS (L-band; 24 cm wavelength) are well-complemented by the sparse but extremely high quality measurements of the L/C band dual-wavelength SIR-C data. We have studied the interferometric coherence and surface deformation fields at. a number of sites of geophysical interest by the methods of differential interferometry: Landers, CA surrounding the 1992 M=7.5 earthquake (ERS); Eureka Valley, CA surrounding the 1993 M=6.1 earthquake (ERS), Nort.bridge, CA surrounding the 1994 M=6.6 earthquake (JERS), and Kilauea volcano, H] over a six month period in 1994 (SIR-C). For Landers and Eureka Valley, three pass interferometry was employed [1] to remove the effects of topography from the int.erferogram. For Northridge anti Kilauea, the method of digital elevation model (DEM) elimination [2.] was used.

The coseismic surface deformation fields of the three earthquakes studied are all greater than the radar wavelength of the data. The geophysical signatures are readily apparent in the differential interferogram. Residual signals of one to several radar wavelengths of equivalent displacement, are visible in all images studied, but generally have spatial variations different. from the phenomenon of jnt.crest. . This residual signal likely consists of differential tropospheric and ionospheric delays, and surface changes such as vegetation growth over the repeat period. Because the earthquake signals are so large, distinctive, and amenable to modeling, quantitative estimates of the structure of the slip on the fault plane are possible.

Surface deformation studies of the Kilauea volcano area were carried out. with l-he SIR-C data to attempt the measurement of more subtle geophysical signals varying with time; Kilauea is known from precise GPS measurements to be actively deforming at a rate of approximately 10 cm per year. The maximum extent of the resulting differential phase signal in the Kilauea interferograms is less than 1 cycle at L-band, equivalent. to less than 12 cm of displacement, and scales well with the wavelength to C-band. This signal is larger than is expected from the GPS measurements by greater than a factor of two. There appears to be a significant component of the di fferential phase due to the vegetation alone, attributable to coherent shift of dielectric properties or the effective L-band scattering center between the two observations (C-band loses coherence in the vegetation) , in addition, there is apparently random variation in the phase equivalent, to a few centimeter displacement in unvegetated regions. Thus, the ability to derive quantitative estimates of displacements smaller than a few centimeters may be hindered by artifacts from the vegetation and atmosphere .